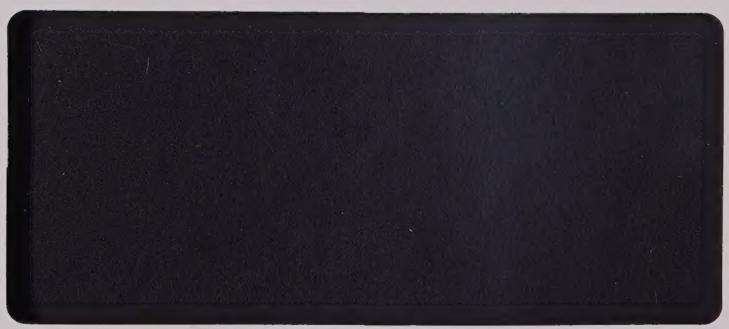
sierra

ID No.
CH 12346
– RETURN TO –
INSTRUMENT CONTROL
SYLVANIA SES -- West
(INSTRUMENT SHOP)

INSTRUCTION MANUAL

FREQUENCY SELECTIVE VOLTMETER MODEL 129A

SIERRA ELECTRONIC DIV.
OF
PHILCO
A SUBSIDIARY OF Ford Motor Company



INSTRUMENT SHOP

ID No. CH 12346
– RETURN TO –
INSTRUMENT CONTROL
SYLVANIA SES -- West
(INSTRUMENT SHOP)

INSTRUCTION MANUAL

FREQUENCY SELECTIVE VOLTMETER MODEL 129A

S/N 113

Stock No. 950000132

Manufactured by

SIERRA ELECTRONIC DIV.

OF

PHILCO

A SUBSIDIARY OF *Ford Motor Company*

AREA CODE 415 – TELEPHONE 326-2060 TWX 492-9224

322-7222 X249 SERV DEPT.

Warranty

SIERRA ELECTRONIC DIVISION, PHILCO CORPORATION warrants instruments manufactured by it and bearing Sierra commercial model numbers, except Ion Gauge Tubes, to be free from defective material and factory workmanship and agrees to repair such instruments, which under normal use and service, disclose the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any such instrument which in our sole opinion upon our examination proves to be so defective, when returned to our factory, transportation prepaid by the purchaser, within one year from the date of original purchase from us.

This warranty does not apply to any of our products which have been repaired, worked upon or altered by persons not authorized by us so as, in our sole judgment, to injure the stability or reliability of such instrument, or which have been subject to misuse, negligence or accident, or the serial number of which has been altered, effaced, or removed. Neither does this warranty apply to any of our products which have been connected, installed, used or adjusted otherwise than in accordance with the instructions furnished by us. Nor does SIERRA ELECTRONIC DIVISION, PHILCO CORPORATION assume any liability for consequential damages, and in any event our liability shall in no case exceed the original purchase price of the instrument. Accessories, including but not limited to all vacuum tubes, fuses and batteries, not of our manufacture used with this product are not covered by this warranty.

SIERRA ELECTRONIC DIVISION, PHILCO CORPORATION reserves the right to make changes in the design or construction of any of its instruments at any time without incurring any obligation to make any changes whatever on units previously purchased.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to represent nor assume for us any liability in connection with the sale of our products other than set forth herein.

TABLE OF CONTENTS

		Page
Section I.	GENERAL	
	A. PURPOSE	1-2
	B. DESCRIPTION	1-2
	C. SPECIFICATIONS	1-3
	D. SPECIFICATIONS MODEL 129-600 LINE BRIDGING TRANSFORMER	1-5
Section II.	OPERATION	
	A. OPERATING CONTROLS	2-1
	B. OPERATIONAL CALIBRATION	2-2
	1. Voltage or DBM Levels	2-2
	2. Cursor Adjustment	2-2
	3. Modulator Balance	2-3
	C. OPERATIONAL MEASUREMENTS	2-3
	D. RESTORED SIGNAL	2-4
	E. SIGNAL GENERATOR	2-4
	1. To Use As A Signal Generator	2-4
	2. To Use As A Tracking Signal Generator	2-5
Section III.	THEORY OF OPERATION	
	A. FUNCTIONAL DESCRIPTION	3-1
	B. CIRCUIT DESCRIPTION	3-3
	1. Input Attenuator Module A1	3-3
	2. 2 KC Reference Oscillator Module A2	3-4
	3. Preamplifier Module A3	3-4
	4. Local Oscillator Module A4	3-4

		Page
5.	Modulator Module A6	3-4
6.	First IF Amplifier Module A5	3-5
7.	Meter Attenuator Module A8	3-5
8.	Second IF Amplifier and Meter Circuit Module A9	3-5
9.	AFC Module A7	3-6
10.	Signal Restorer Module A10	3-6
11.	Power Supply	3-7

Section IV. MAINTENANCE

A.	GENERAL	4-1
B.	CALIBRATION	4-2
1.	Test Equipment Required	4-2
2.	Power Supply	4-2
3.	Local Oscillator, Coarse Alignment	4-4
4.	IF Amplifiers	4-4
5.	Modulator Balance	4-6
6.	AFC Alignement	4-6
7.	Crystal Oscillator	4-6
8.	Local Oscillator Tracking	4-8
9.	Input Attenuator Tracking	4-8
10.	Input Attenuator Frequency Response	4-9
11.	IF Low-Pass Filter Adjustment	4-9
12.	Meter Attenuator Tracking	4-9

Section V. REPLACEABLE PARTS LIST

LIST OF ILLUSTRATIONS

Figure No.		Page
1-1	Model 129A Frequency Selective Voltmeter	1-1
3-1	Model 129A Block Diagram	3-2
3-2	Frequency Selective Voltmeter Model 129A Schematic Diagram	3-8
4-1	Left Rear View, Module Location	4-3
4-2	Right Rear View, Module Location	4-5
4-3	Bottom View, Module Location	4-7

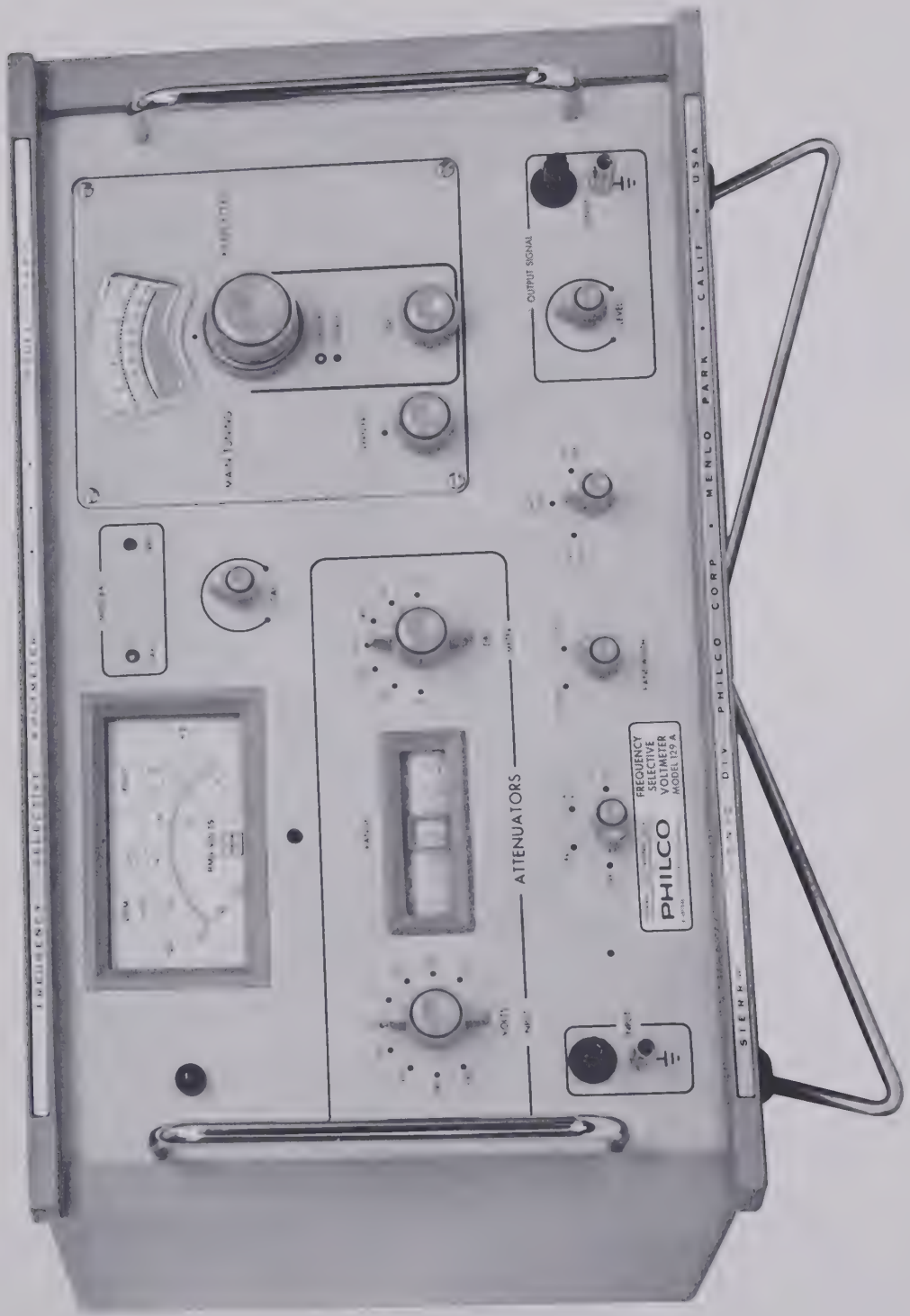


Figure 1-1 Model 129A Frequency Selective Voltmeter

SECTION I
GENERAL

A. PURPOSE

The Sierra Model 129A Frequency Selective Voltmeter is an extremely selective, highly sensitive tunable voltmeter covering the range of 10 cps to 100 kilocycles. Its purpose is to measure the amplitude and frequency of all types of electrical signals, selecting a very narrow band at a particular frequency out of the frequency spectrum. It may be used to measure harmonic voltages, intermodulation products, signal voltages in the presence of noise, signal voltages too small to be measured by other means, the vibration components of mechanical systems or any recurrent phenomena that can be converted to electrical impulses.

The Voltmeter has two operational modes: either with a restored signal output that is identical in frequency to the input signal, or with an internally generated signal output, the frequency of which is the same as that to which the voltmeter is tuned.

B. DESCRIPTION

The Model 129A is full transistorized. Modular circuit boards are used for component mounting and the low level modules are enclosed in shielded compartments.

The instrument is normally operated from a 115 volt ac supply, but up to six hours of independent operation is provided by a self-contained, rechargeable nickel cadmium battery.

Two attenuators adjust for signal level input over the full instrument range. They are mechanically connected to a drum dial with a sliding mask that indicates the meter reading range, either volts or dbm, for any combination of attenuator settings. The meter reads volts directly, across any impedance. Dbm level must be measured across 600 ohm circuits only.

A 2 kc reference oscillator serves as an internal standard for level calibration.

Selectivity may be either wideband, 100 cps, or narrow band, 10 cps, as chosen by a front panel switch. Since the signal source being examined may be slightly unstable, an AFC circuit is used. This circuit holds the signal within the pass band of the 10 cps filter for slow signal frequency drifts of ±300 cycles or more. AFC may be switched in or out with a front panel control.

To provide a permanent record of measured circuit conditions, a recorder may be plugged into the meter circuit. Recorder input resistance may be as high as 5000 ohms without degrading meter accuracy.

The restored signal mode of operation is useful when the frequency of one signal out of a group, or a signal partly masked by noise needs to be accurately measured. A frequency counter attached to the voltmeter output will see only the desired signal free from interference or noise, the voltmeter thus acting as a very selective, tuneable filter.

In the Signal Generator mode of operation the frequency of the output is the same as that to which the voltmeter is tuned. This makes possible a frequency response measurement on a circuit or network by tuning only one dial. Both voltmeter and signal generator will automatically be on the same frequency.

C. SPECIFICATIONS

Frequency Range	10 cps to 100 kc
Frequency Accuracy	
At 10 cps	±50 cps
At 100 cps	±75 cps
At 1 kc	±100 cps
Above 10 kc	±200 cps
Input Level Range	
Voltage	
30 cps to 100 kc	30 μv to 300 v
10 cps to 30 cps	30 mv to 300 v
Dbm (Ref. 600 ohm line and 0 db on meter scale)	+50 to -90 dbm
Input Level Accuracy	
+50 to -100 dbm	±0.5 db
Input Impedance (Unbalanced*)	100K ohms resistive
Selectivity	
Narrow Band (10 cps)	
6 db bandwidth	10 cps ±2 cps
60 db bandwidth	60 cps or less

*Balanced to unbalanced transformer, Model 129-600 available as optional equipment. See specifications page 1-5.

Wide Band (100 cps)	
6 db bandwidth	100 cps ±20 cps
60 db bandwidth	600 cps or less
Spurious Response	
IF (205 kc) Rejection	Greater than 80 db
Residual Modulation Products and Hum	Greater than 70 db down
Automatic Frequency Control	
Hold-in range	±300 cps minimum
Recorder Output	
Current (Meter full scale)	200 μa dc
Recorder Input Resistance (ungrounded)	5000 ohms maximum
Signal Generator or Restored Signal Output	
Level (open circuit)	1 volt rms
Output Impedance	600 ohms
Output Attenuator Range	0-40 db continuously variable
Power Requirements	
Commercial Power Mains	
Voltage	105-125 volts rms
Frequency	50-1000 cps
Input Power	3 watts (approx.)
Power Source (self-contained)	12 volt battery (rechargeable)
Operating Time	Up to 6 hours
Recharge Time	
At Full Charge Rate	10-12 hours
Normal Operation	40-50 hours
Dimensions	
Width	19-5/8 inches
Height	11-1/4 inches
Depth	12-1/2 inches
Weight	36 pounds
Rack Mounting	Remove Panel Trim and Cabinet

D. SPECIFICATIONS

MODEL 129-600 LINE BRIDGING TRANSFORMER

Impedance	
Terminated, Balanced Line	600 ohms
Frequency Range	2 kc to 100 kc
Maximum Input Level	+32 dbm/600 ohms
Frequency Response	±0.3 db
Bridging Loss (600 ohm line)	0.2 db max. 2 kc to 10 kc 0.1 db max. 10 kc to 100 kc
Maximum Voltage	400 volts peak, AC + DC
Dimensions	2 x 2-7/8 x 5-5/8 inches
Weight	11 ounces

SECTION II
OPERATION

A. OPERATING CONTROLS

The following table lists the front panel controls, a brief description of the use of each and the schematic reference number of the control.

Control or Indicator	Use	Schem. Ref. No.
INPUT ATTENUATOR	Attenuates signal to suitable level for preamplifier input	S2
RANGE	Drum dial and sliding mask indicates full scale meter range for any combination of attenuator settings	
METER ATTENUATOR	Attenuates signal to suitable level for meter reading range	S4
Function Switch	Controls following functions: Power Off, Operation, Calibration, Battery Charge	S1
BANDWIDTH	Selects wide or narrow bandwidth	S5
AFC/SIG GEN	Selects AFC On or OFF, Selects Signal Generator mode	S3
MAIN TUNING COARSE	Rapid tuning of frequency dial	A4C2
FINE	Fine frequency tuning	A4C2
VERNIER	Extra fine frequency tuning	A4C11
CAL	Overall Voltmeter gain adjustment	R11
OUTPUT SIGNAL LEVEL	Sets level of output signal	R7, R8

Control or Indicator	Use	Schem. Ref. No.
MOD BAL CAP	Capacitive adjustment to minimize LO feedthrough	A6C2
RES	Resitive adjustment to minimize LO feedthrough	A6R5
RECORDER	Output jack for recorder connections	J24
METER	Calibrated to read volts directly, to read dbm across 600 ohm circuits only.	M1

B. OPERATIONAL CALIBRATION

1. Voltage or DBM Levels

Calibration procedure sets the overall gain of the voltmeter according to the internal standard, the 2 kc Reference Oscillator. For measurement of absolute levels the calibration procedure should be carried out before each series of readings is taken. Procedure follows:

a. Set Function switch to CAL 2KC.

b. Set METER ATTENUATOR to 0 db.

c. Set BANDWIDTH switch to 100 cps.

d. Set AFC/SIG GEN switch to AFC OFF.

e. Set MAIN TUNING to 2 kc. Adjust for maximum meter reading.

f. Adjust CAL control until meter reads exactly 0 db.

NOTE

Voltmeter level calibration must be carried out at the 2 kc point only. (Oscillator frequency is nominal, calibration is for level only.)

2. Cursor Adjustment

Cursor should be centered in its range of adjustment. If a very accurate cursor setting is required:

a. Set AFC/SIG GEN switch to SIG GEN.

b. Connect a Frequency Counter to the voltmeter output.

c. Adjust voltmeter until Frequency Counter reads a frequency corresponding to a dial division on the MAIN TUNING dial of the voltmeter.

d. Adjust cursor until index point is at the proper division on the MAIN TUNING dial.

(The Reference Oscillator is not used to check the dial frequency setting since it is stabilized for level only.)

3. Modulator Balance

When measurements are to be made near the low end of the voltmeter frequency range, the Modulator Balance should be checked in order that level accuracy may be maintained. Modulator Balance prevents feedthrough of the Local Oscillator frequency. Procedure follows:

a. Disconnect voltmeter INPUT from any signal source.

b. Turn Function switch to OPR.

c. Set BANDWIDTH switch to 100 cps.

d. Turn AFC/SIG GEN switch to AFC OFF.

e. Set METER ATTENUATOR switch to -40 db.

f. Turn MAIN TUNING dial to 0 frequency and tune carefully for a meter indication. Tune for maximum indication. The METER ATTENUATOR switch may have to be adjusted to get a good meter reading.

g. With a small screwdriver, very carefully adjust MOD BAL CAP and RES for minimum meter reading. Adjustment is quite critical and meter may be driven off scale quite easily. First adjustment should be made with METER ATTENUATOR set at -40. For finer adjustments set to higher sensitivity as necessary. Adjustment for a minimum meter reading of -50 or less should be possible.

C. OPERATIONAL MEASUREMENTS

1. For maximum accuracy the Operational Calibration procedure of paragraph B.1. above should be carried out before each series of measurements is made.

2. Set INPUT ATTENUATOR for a voltage equal to or greater than the maximum expected voltage of the fundamental of the input signal. Set METER ATTENUATOR to 0 DBM. If fundamental signal voltage is unknown, measure fundamental before measuring other signal components.

3. Connect output of circuit or equipment to be checked to the voltmeter input terminals.

4. Turn Function switch to OPR.

5. Set BANDWIDTH switch to 100 cps.

6. Set AFC/SIG GEN switch to AFC OFF.

7. Tune MAIN TUNING dial to the frequency of the signal to be measured and adjust METER ATTENUATOR for a reading in upper portion of meter scale. The INPUT ATTENUATOR must remain set for a voltage equal to or greater than the maximum fundamental signal voltage in order to prevent the possible generation of spurious signals in the preamplifier.

8. Set AFC/SIG GEN switch to AFC ON.

9. Turn BANDWIDTH switch to 10 cps.

10. Read meter according to scale indicated on RANGE chart.

Voltage is read directly according to the full scale range indicated on the RANGE chart. Dbm is the algebraic sum of the meter db reading and the db reading on the RANGE chart.

Dbm level measurements may be made across 600 ohm circuits only.

D. RESTORED SIGNAL

To measure the frequency of an input signal, connect a Frequency Counter to the output terminals. Adjust gain with OUTPUT SIGNAL LEVEL control. Frequency of the restored output signal is exactly the same as the signal to which the voltmeter is tuned. The restored signal is free of the noise and interfering signals that may be present at the voltmeter input.

E. SIGNAL GENERATOR

1. To use as a Signal Generator.

a. Connect OUTPUT to circuit or equipment to be checked.

b. Place AFC/SIG GEN switch in SIG GEN position.

c. Turn MAIN TUNING dial to the desired output frequency.

d. Set Signal Generator level with OUTPUT SIGNAL LEVEL control.

2. To use as a Tracking Signal Generator.

a. Connect OUTPUT of voltmeter to input of circuit or network to be checked.

b. Connect output of circuit or network to INPUT of voltmeter.

c. Adjust Signal Generator output to proper level with OUTPUT SIGNAL LEVEL control.

d. Adjust INPUT and METER ATTENUATORS for a suitable meter reading.

e. Rotate MAIN TUNING dial through desired frequency range and read level data from meter. A recorder may be plugged into the RECORDER jack to make a permanent record of levels.

SECTION III
THEORY OF OPERATION

A FUNCTIONAL DESCRIPTION

The signal is brought into the Voltmeter to the preamplifier through the input attenuator, which is adjustable from +50 to -30 dbm providing up to 80 db attenuation. Refer to Block Diagram Figure 3-1. Attenuation is switched in according to the amplitude of the signal to be measured.

The Preamplifier includes the low-pass filter which removes all signals above the frequency range of the Voltmeter to prevent spurious responses due to those signals. Signal level is increased 30 db by the Preamplifier after which it is applied to the Ring Bridge Modulator.

The Local Oscillator frequency is adjustable with the front panel controls as well as with a varactor diode which provides AFC. Local oscillator output is applied to the Ring Bridge Modulator along with the input signal. The resultant Modulator output is the 205 kc intermediate frequency. An output from the Local Oscillator is also fed to the Modulator in the Signal Restorer circuit.

The First IF amplifier includes the 100 cycle bandpass crystal filter which sets the overall bandwidth of the instrument in the wide band mode. Overall gain of the First IF amplifier is 25 db.

From the First IF amplifier the signal goes to the Meter Attenuator where the level is adjusted to obtain a suitable meter reading. The Meter Attenuator is adjustable from 0 to -60 dbm.

The Second IF amplifier also operates at 205 kc. It includes both the 10 cycle bandwidth filter and the CAL adjustment for level calibration. When the 10 cycle filter is switched out of the circuit a resistive network is switched in to replace it so that the overall gain of the amplifier is not changed. Second IF amplifier gain is 60 db.

From the Second IF amplifier the signal is applied to the meter detector and the detector output to the meter for readout. A jack in series with the meter permits plugging in an external recorder. The meter reading is not affected as long as the recorder input resistance is 5000 ohms or less.

Two other outputs are taken from the Second IF amplifier. One output is taken off ahead of the 10 cps filter for the AFC circuits. This signal is amplified, limited and applied to the discriminator. Discriminator output is the error voltage applied to the varactor diode,

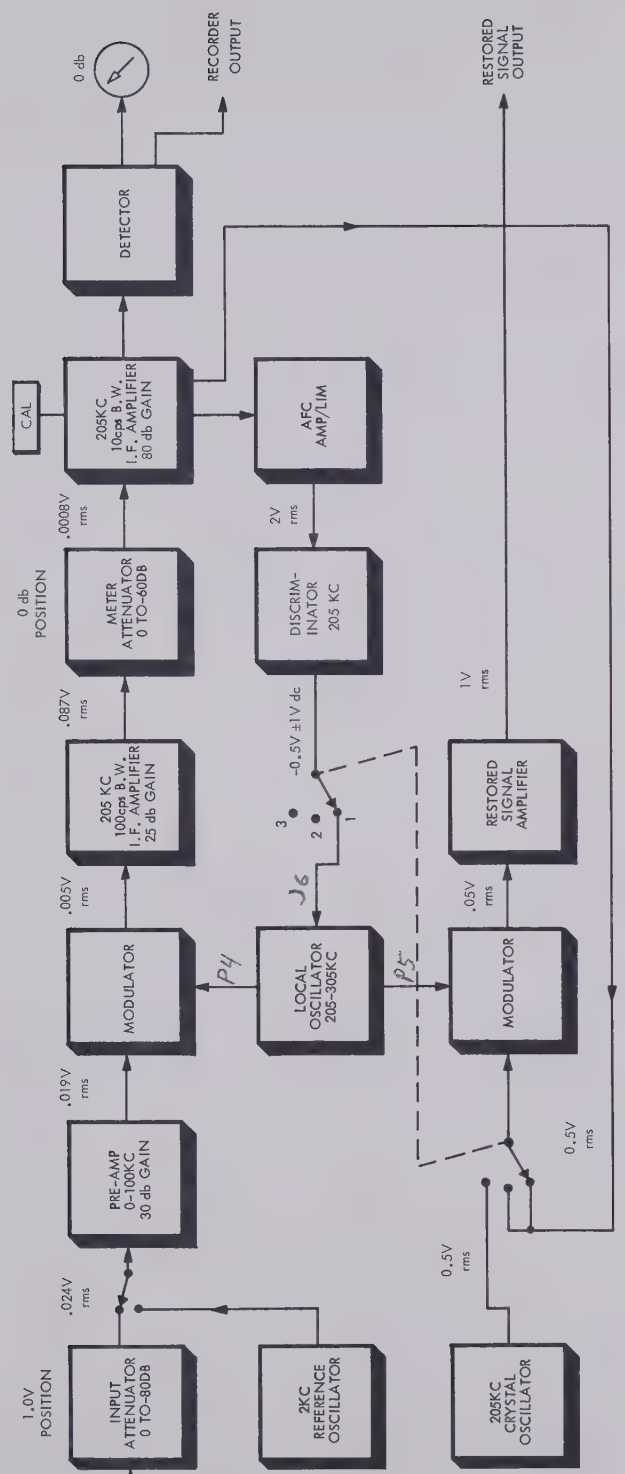


Figure 3-1. Model 129A Block Diagram

a voltage variable capacitor, in the Local Oscillator. Error voltage output is of such a polarity that the change in capacity of the varactor diode counteracts any change in intermediate signal frequency due to the signal drift or drift of the Local Oscillator. This AFC maintains the IF near the center of the 10 cps filter pass band.

The other output from the Second IF amplifier is applied to the Modulator in the Signal Restorer circuit to produce the regenerated output signal. Since the same Local Oscillator is used to convert the input signal to IF and to convert IF to the output signal, the frequency of both input and output signals is identical.

When set for the Signal Generator mode a crystal controlled 205 kc oscillator is connected to the Signal Restorer circuit in place of the Second IF signal. The Signal Generator output frequency is therefore the same as the frequency to which the Voltmeter is tuned.

The 2 kc Reference Oscillator is connected to the input of the Preamplifier in the CAL position of the Function switch. This oscillator provides the internal standard by which the overall gain of the voltmeter is set so that absolute voltage or dbm measurements may be made.

B. CIRCUIT DESCRIPTION

The components making up the circuits of the 129A Frequency Selective Voltmeter are mounted on printed circuit boards, with the exception of the power supply components and the front panel controls. Shielding is employed where necessary. Each main circuit board is designated as a module with an identifying number (A1-A10). The circuit reference numbers of components in each module begin with number one. The full reference number of a component is the module number followed by the component circuit reference number. Thus: A1R1 refers to the first resistor in the circuit board module number A1. The front panel mounted controls and the power supply components are separately numbered in consecutive order. In the following circuit description only those components outside the module being described will be referred to by the full reference number. Other components mentioned belong to the module being described or to the front panel and power supply. Refer to Schematic Diagram Figure 3-2.

1. INPUT ATTENUATOR MODULE A1

Signal input to the Voltmeter passes through the INPUT ATTENUATOR where level to the preamplifier may be adjusted over a range of +50 to -30 dbm in 10 db steps. The attenuator is a resistive divider network with frequency compensation where necessary. Input impedance to the attenuator is 100,000 ohms for all control settings. The INPUT ATTENUATOR front panel control, S2, is mechanically connected to the rotating drum of the RANGE indicator.

2. 2 KC REFERENCE OSCILLATOR MODULE A2

As an internal reference standard, this oscillator provides a means of accurately setting the overall gain of the voltmeter for the purpose of making absolute measurements. Q1 and Q2 are connected in an astable multivibrator circuit and generate a rectangular output wave. Voltage to the module is regulated by zener diode CR1 to provide for stability of output level. Due to the square wave shape of the oscillator output, harmonics may be found every 2 kc over the full instrument tuning range. Only the 2 kc signal should be used for level calibration. The Reference Oscillator is not used to check the dial frequency setting since it is stabilized for level only.

3. PREAMPLIFIER MODULE A3

Input to the preamplifier from either the INPUT jacks through the attenuator, or from the Reference Oscillator, is selected by Function switch S1A. Refer to Block Diagram Figure 3-1 and Schematic Diagram Figure 3-2. Signals are amplified by emitter-followers Q1, Q2 and common-emitter amplifier Q3, which also provides an impedance match for the input of the low-pass filter. Feedback from the emitter of Q3 to the base of Q1 contributes to the amplifier stability and considerably increases the input impedance of Q1. Signals above the maximum range of the instrument are eliminated by the low-pass filter which has a cutoff frequency slightly above 100 kc. Q4 terminates the filter and feeds the signal to the center tap of A5T1. Potentiometer R2 adjusts the input impedance to the preamplifier for calibration purposes. Diodes CR1, CR2 are peak clippers to protect the input transistor from excessive signal peaks. Total power gain of the preamplifier is 30 db.

4. LOCAL OSCILLATOR MODULE A4

The Local Oscillator signal is generated by Q1 connected in a Colpitts oscillator circuit. C2 is the COARSE frequency front panel control and C11 is the VERNIER adjustment. C10 is a Varactor diode, a voltage variable capacitor, which is part of the tuned circuit of the Local Oscillator. Error voltage output from the discriminator stage causes the varactor diode capacity to change in such a direction as to correct for frequency drift, and thus provides automatic frequency control. Q2 amplifies the oscillator output and Q3 provides impedance matching to the modulator transformer A6T1. An output, taken out through J5, goes to the Signal Restorer circuit to be used for signal regeneration. Voltage to the oscillator is regulated by zener diode CR1 and additional filtering is provided by C1.

5. MODULATOR MODULE A6

Mixing of the Local Oscillator and input signals to generate the 205 kc intermediate frequency is accomplished with a Ring Bridge Modulator. Four diodes, CR1-CR4, are connected in a ring bridge circuit. The Local Oscillator signal is applied to one set of bridge diagonals through modulator transformer T1. The incoming signal is connected

to the centertap of the primary of transformer A5T1 and the primary connected across the other set of bridge diagonals.

The action of the modulator is briefly as follows: As polarity of the Local Oscillator signal applied across the bridge is reversed, one set or the other of two sets of diodes becomes conductive. Signal can flow only out of the side of the primary of A5T1 connected to the conducting set of diodes. This signal flow is thus switched from one half of the primary of A5T1 to the other at the Local Oscillator frequency rate. The effect is to generate sum and difference frequencies (Local Oscillator frequency plus and minus the incoming frequency). The frequencies present in the secondary of A5T1 are therefore the incoming signal frequency and the sum and difference frequencies. The Local Oscillator signal is balanced with respect to ground and does not appear. Exact balance to eliminate the Local Oscillator frequency is obtained by adjusting C2 and R5. These are the CAP and RES controls of the front panel MOD BAL adjustment. Unwanted signals out of A5T1 are filtered out in Module A5.

6. FIRST IF AMPLIFIER MODULE A5

Signal output from T1 is applied to the tuned amplifier Q1, then to Q2 which provides an impedance match to the input of the 100 cycle band-pass filter, and then to Q3 which provides output filter impedance matching. All frequencies out of the modulator, which fall outside the pass band of the 100 cycle filter, are eliminated and only the difference frequency is selected and passed through the filter. Overall power gain of the First IF Amplifier is 25 db. Decoupling filters L2, L3, C6, C8, C9 prevent feedback around the filter.

7. METER ATTENUATOR MODULE A8

A second attenuator is connected between the First and the Second IF amplifiers to control the overall IF amplifier gain. Attenuation is adjustable from 0 to -60 dbm in 10 db steps. The METER ATTENUATOR front panel control S4, is mechanically coupled to the sliding window mask of the RANGE indicator.

8. SECOND IF AMPLIFIER AND METER CIRCUIT MODULE A9

The input stage Q1 of the Second IF amplifier provides impedance matching between the METER ATTENUATOR and the 10 cps band-pass filter without loss of gain. In addition, the sampling signal for the AFC circuits is taken off from the emitter of Q1. R2 adjusts input impedance to this stage for calibration purposes. BANDWIDTH switch S5, connects either the 10 cps filter or a resistive substitution network into the circuit. Signal loss through the substitution network is adjusted with R3 so that there is no change in gain whether the 10 cps filter is in or out of the circuit. From the 10 cps filter the signal passes to amplifier stage Q2 which is tuned to 205 kc. The gain of the following stage, Q3, is controlled by front panel CAL control, R11, to set the overall sensitivity of the instrument during operational calibration.

After being amplified by Q4 and Q5, the signal is applied to the meter rectifier, CR1, CR2, C20, C21. R30 in the rectifier circuit is also part of the emitter resistance of Q4. This produces heavy feedback over stages Q4, Q5 which results in a very linear meter response. Closed circuit jack, J24, in series with the meter is the connection for an external recorder. Recorder input resistance up to 5000 ohms can be tolerated. An additional stage, Q6, connected as an emitter-follower takes off a sample of the 205 kc IF signal for application to the Signal Restorer circuit.

9. AFC MODULE A7

A signal output from the emitter of A9Q1 is fed to the broadly tuned three stage AFC amplifier Q1, Q2, Q3 through J16 and J10. Amplifier output is applied to the diode limiter stage CR1, R15, R16 and CR2, R13, R14 and then through emitter-follower amplifier Q4 to the crystal discriminator circuit, which is made up of C13,C14, C15, CR3, CR4, R20, R21 and crystal Y1. Briefly described, the discriminator circuit operates as follows: At frequencies below resonance the crystal appears as a capacitance. As the frequency is increased a crystal series resonance point is reached and impedance falls to a minimum. As frequency continues to be increased the crystal impedance increases in a linear fashion until a parallel resonance point is reached and impedance is maximum. At higher frequencies impedance slowly falls off. Due to the effect of these crystal resonances, the dc voltage developed across the two diodes varies, as the applied frequency increases, from maximum negative at the series resonant point to maximum positive at the parallel resonant point thus forming the familiar discriminator S curve.

C14 adjusts the crystal response so that zero output voltage occurs at the 205 kc intermediate frequency. AFC control voltage is taken out through J13, S3A and applied to the varactor diode A4C10 in the Local Oscillator. If the 205 kc IF changes because of a variation of the incoming signal frequency or of the Local Oscillator frequency, the AFC voltage applied to the varactor diode changes with a polarity that corrects the Local Oscillator frequency by the change in the capacitance of the varactor diode. In this way the AFC circuit locks on a signal and maintains the IF very close to the center frequency over a signal variation of more than ±300 cps.

In the AFC OFF mode the bias voltage set by divider R18, R19 is applied to the varactor diode through J14 and S3A, so that it is maintained at a single fixed value of capacity for this mode of operation.

10. SIGNAL RESTORER MODULE A10

a. Signal Restorer Circuit. Output from the Local Oscillator is brought through J5 and J17 to the Signal Restorer amplifier Q1, and from there it passes to the primary of the modulator transformer T2. The secondary of T2 is connected to one set of diagonals of the ring bridge CR1-CR4. Output from the Second IF amplifier A9Q6 is brought in through S3B and J18 to the primary of modulator transformer T1. The secondary of T1 is connected to the other pair of diagonals of the ring bridge. Sum and difference frequencies are developed in the modulator, as described in paragraph 5. above, and the

difference frequency is selected by the low-pass filter L2, L3, C4, C5, C6. Since the same Local Oscillator is used to generate both the IF and the restored signal, the frequency of the restored signal is exactly the same as the input frequency. Level of the restored signal available at the OUTPUT connector is adjustable over a 40 db range with level control R7, R8. Maximum open circuit output voltage is approximately 1 volt rms.

b. Signal Generator Circuit. In the Signal Generator mode the 205 kc output of crystal oscillator Q6 is connected through Q5, J19 and S3B to modulator transformer T1 in place of the 205 kc IF signal. Operation is the same as in signal restoration except that the signal source is internal. In this way a signal is generated which is the same frequency as that to which the voltmeter is tuned. Output is adjustable with R7, R8.

11. POWER SUPPLY

A solid state rectifier with a choke input filter supplies the -12 volts dc required by the voltmeter. A nickel-Cadmium rechargeable battery is floating across the supply output in normal operation. The battery serves as a voltage regulator for the power supply and also provides additional filtering. In addition the charge on the battery is maintained in this way. The capacity of the battery is sufficient to afford up to six hours operation of the Voltmeter independent of an ac supply. After extended use the battery may be rapidly recharged by setting the Function switch S1 to CHG. In this switch position the power supply is disconnected from the voltmeter, the power supply transformer primary tap is changed to increase the charging voltage and the meter is connected to the battery through a multiplier resistor. A meter reading at the CHG mark indicates the battery is approximately fully charged. Charging current is entirely dependent on the battery condition and may vary from a few milliamperes to more than 50 ma.

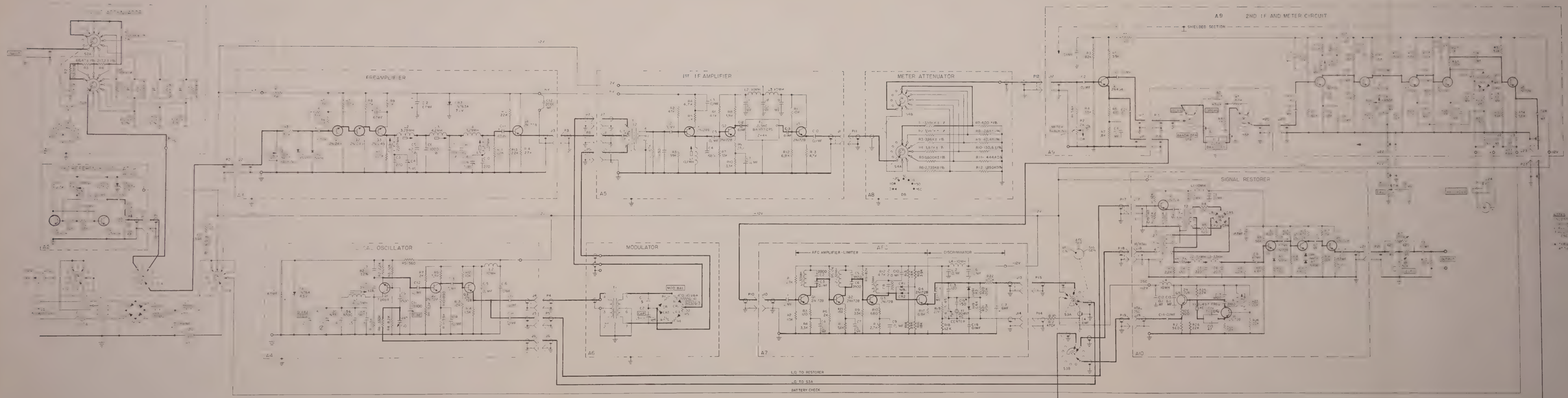


Figure 3-2. Frequency Selective Voltmeter
Model 129A Schematic Diagram

SECTION IV
MAINTENANCE

A. GENERAL

Since the Model 129A is all solid state and is a conservatively designed instrument, it may be expected to provide many hours of trouble free operation.

Probable expected order of trouble is: run down battery due to insufficient charging time, incandescent panel lamp failure, development of noise in most frequently used controls, power supply diode failure, increased leakage or complete failure of transistor, increased leakage of capacitors and change in value of resistors.

If trouble developes, a good understanding of circuit operation and signal flow paths as outlined in the Theory of Operation, Section III, and the Schematic Diagram, Figure 3-2, will aid greatly in tracing the cause. Power supply B- voltages are indicated on the Schematic Diagram. Signal levels and voltages at significant points in the instrument are shown in the Block Diagram, Figure 3-1.

If battery and power supply voltages are normal, the following general procedure for rapid fault isolation is suggested.

Apply a 0 db test signal to the Input terminals. Check at a point half way through the instrument, along the main signal path, for normal indication according to levels given in the Block Diagram. If indication is normal, select a point half way toward the output from the last check point for the next check. If indication is abnormal at the first check point, select a point half way toward the input. Follow this procedure until faulty operation has been localized between two closely spaced check points. If this procedure indicates difficulty in one of the branch signal paths, follow the same half way point procedure to localize faulty section. When the faulty section has been isolated, detailed checking can soon indicate the source of the trouble. Complete transistor failure is indicated by: no difference in voltage across a junction - junction shorted, or excessive voltage across a junction - junction open.

After trouble has been cleared the calibration procedure given in paragraph B below should be carried out.

Module locations are given in Figures 4-1, 4-2, 4-3.

B. CALIBRATION

Calibration of the instrument should be checked on a routine basis about every six months and the calibration procedure carried out if necessary. If instrument has been repaired, calibration should be checked before placing it back in service.

1. Test Equipment Required

Audio Oscillator	HP 200CD or equivalent
AC Vacuum Tube Voltmeter	HP 400L or equivalent
Multimeter	Simpson 260 or equivalent
Frequency Counter	HP 524C or equivalent
Oscilloscope	Tektronix 543 or equivalent
Variable Attenuator 600 ohms	Daven VT-795-G or equivalent
Variable Voltage Transformer	GR W5MT3A or equivalent

2. Power Supply

a. Turn Function switch to OFF position.

b. Disconnect orange lead from negative terminal of battery. Clip negative lead of multimeter to orange battery lead. Clip positive multimeter lead to negative terminal of battery. Set meter to highest current range.

c. Adjust line voltage to 115 volts with Variable Voltage Transformer. Plug 129A line cord into Variable Voltage Transformer. Turn Function switch to OPR position. Current indication should be between 5 and 10 ma.

d. Turn Function switch to CAL. Current indication may be anywhere between 5 ma charge to 5 ma discharge. This is due to the 15 ma drawn by the Reference Oscillator.

e. Set current range to 100 ma or higher. Turn Function switch to CHG. Current indication should be from 35 to 55 ma.

f. Turn Function switch to OFF. Disconnect line cord from AC source. Reverse Multimeter test leads. Turn Function switch to OPR. Battery discharge current should be less than 100 ma.

g. Turn Function switch to OFF. Disconnect Multimeter and resolder orange wire to negative battery terminal. Reconnect AC cord to 115 volt AC source. Turn Function switch to OPR. Measure voltage across battery. Should be 13 volts ±1 volt.

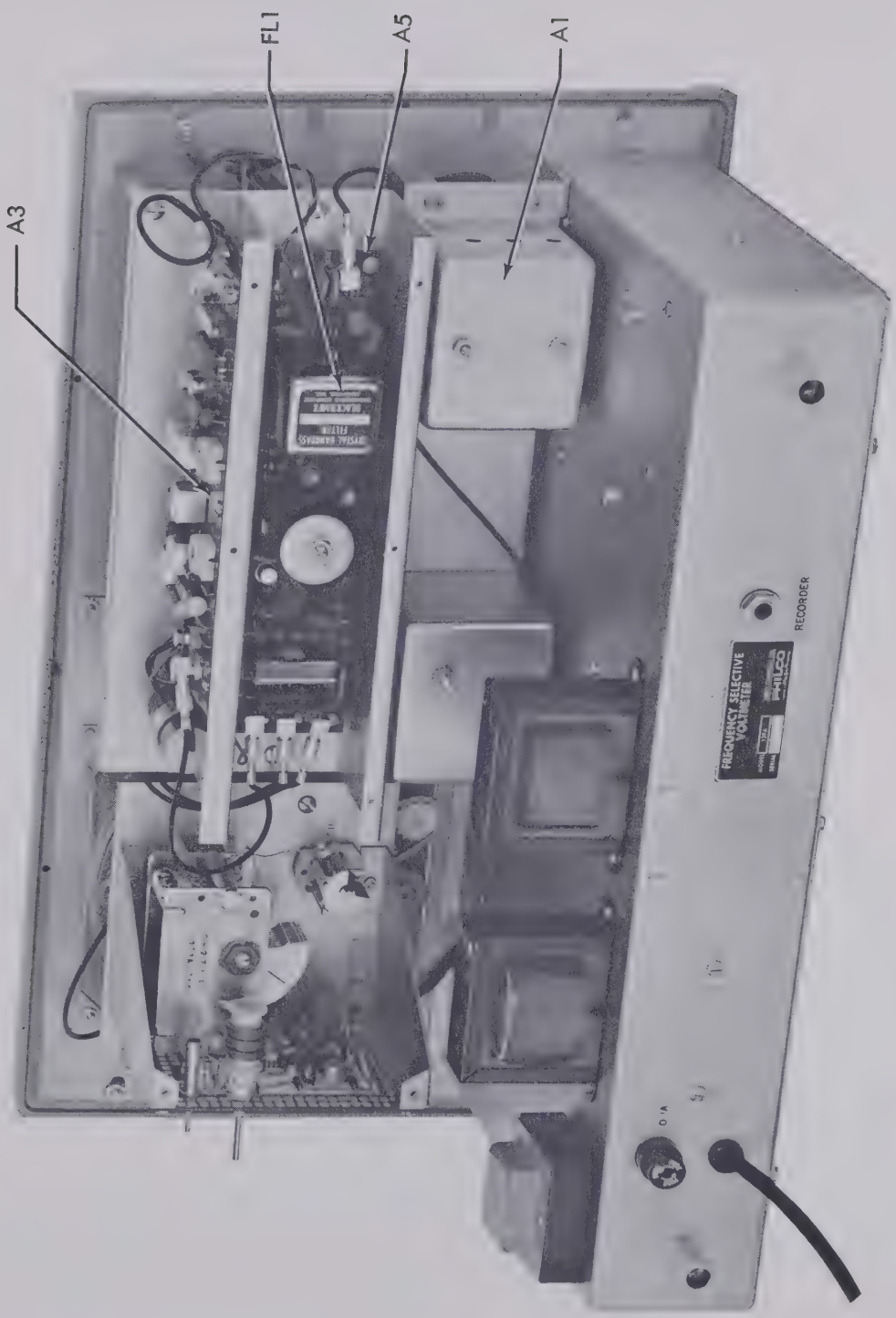


Figure 4-1. Left Rear View, Module Location

3. Local Oscillator, Coarse Alignment

This section may be omitted unless it is known that instrument is very badly out of alignment.

a. With Main Tuning dial at upper (max. CCW) limit of rotation, Main Tuning capacitor should be fully unmeshed. Readjust, if necessary, by loosening lock nut of capacitor shaft, repositioning shaft and retightening lock nut.

b. With Vernier control at CCW limit, A4C11 must be fully meshed. If adjustment is necessary, loosen gear on capacitor shaft, slip capacitor to proper position and retighten gear. Replace cover on oscillator assembly.

c. Connect instrument to 115 volt AC source. Center Cursor and Vernier controls. Set Main Tuning dial to 0 kc.

d. Place instrument on its right side. Set Function switch to OPR. Connect Oscilloscope probe to the junction of A10R1 and A10R2 on the Signal Restorer circuit board. Connect vertical output of Oscilloscope to Frequency Counter. (Do not use chopped or alternate display modes if a dual-trace preamplifier is used.)

e. Adjust A4L1, using a non-ferrous alignment tool, to 205.00 kc. Rotate the Main Tuning dial to 100 kc and adjust A4C3 for a frequency of 305.00 kc. Repeat these two adjustments until end-points are maintained within 50 cps. Disconnect Oscilloscope probe.

4. IF Amplifiers

a. Set Function switch to OPR, Volts Range switch to 1.0V, DB Range switch to 0 db, Bandwidth switch to 100 cps, Main Tuning dial to 10.0 kc and AFC to OFF.

b. Connect Audio Oscillator to Input of 129A. Adjust input signal to 1.0 volt at 10 kc. Tune 129A for peak meter indication. Adjust Cal Range control A9R19 to keep meter reading on scale.

c. Adjust A5L1 (1st IF Amp) for peak meter reading. Adjust A9L1 (2nd IF Amp) for peak meter reading.

d. Turn Bandwidth switch to 10 cps position and fine-tune for maximum meter indication with Vernier control. Readjust A9R19 for a meter indication of 1.0 volt. Remove input signal. (This is a preliminary meter level adjustment.)

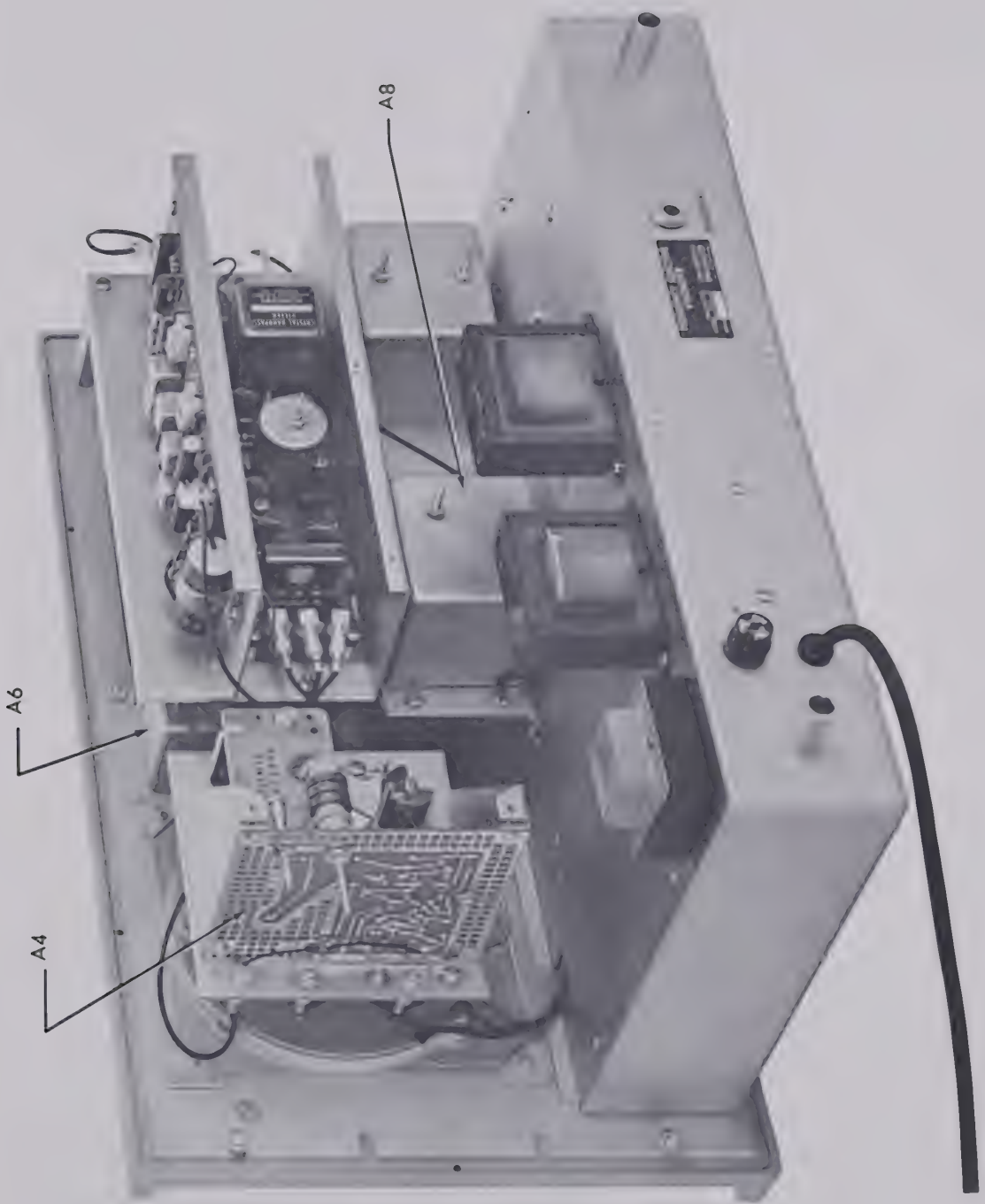


Figure 4-2. Right Rear View, Module Location

5. Modulator Balance

a. Set Function switch to OPR, DB Range switch as necessary to keep meter reading on scale, Bandwidth switch to 100 cps, AFC to OFF, Main Tuning dial to 0.0 kc.

b. Fine-tune with Vernier control for peak meter indication at 0.0 kc.

c. Alternately adjust MOD BAL controls RES (A6R5) and CAP (A6C2) for lowest possible meter reading.

6. AFC Alignment

a. Set Function switch to OPR, Volts Range switch to 1.0 volt, DB Range switch to 0 db, Bandwidth to 10 cps, AFC to OFF and set Main tuning at 2 kc.

b. Connect Audio Oscillator to input of 129A and apply a 0 db, 2 kc signal. Fine tune for maximum meter indication and adjust input for reading of exactly 0 db.

c. Turn AFC to ON position. Adjust AFC centering capacitor A7C14 to obtain meter reading of exactly 0 db. (Meter pointer should have no discernable flutter. Flutter is an indication of mistuning.)

d. Carefully tune Audio Oscillator to 0.5 db points each side of center frequency. These points should fall within ±500 cps of center frequency.

7. Crystal Oscillator

a. Set Function switch to OPR, Volt Range switch to 1.0 volt, DB Range switch to 0 db, Bandwidth to 10 cps and Afc/Sig Gen switch to SIG GEN. Set Main Tuning to 2 kc.

b. Connect Oscilloscope probe to either side of A10R20 (820 ohms) on Signal Restorer circuit board. Adjust A10L5 for maximum output from crystal oscillator as indicated on Oscilloscope.

c. Connect AC VTVM to Output jacks of 129A. Adjust LEVEL control for 0 db reading on AC VTVM.

d. Connect clip lead from OUTPUT to INPUT terminals of 129A. Adjust oscillator trimmer A10C16 for peak ~~(0 dbm)~~ indication on 129A panel meter.

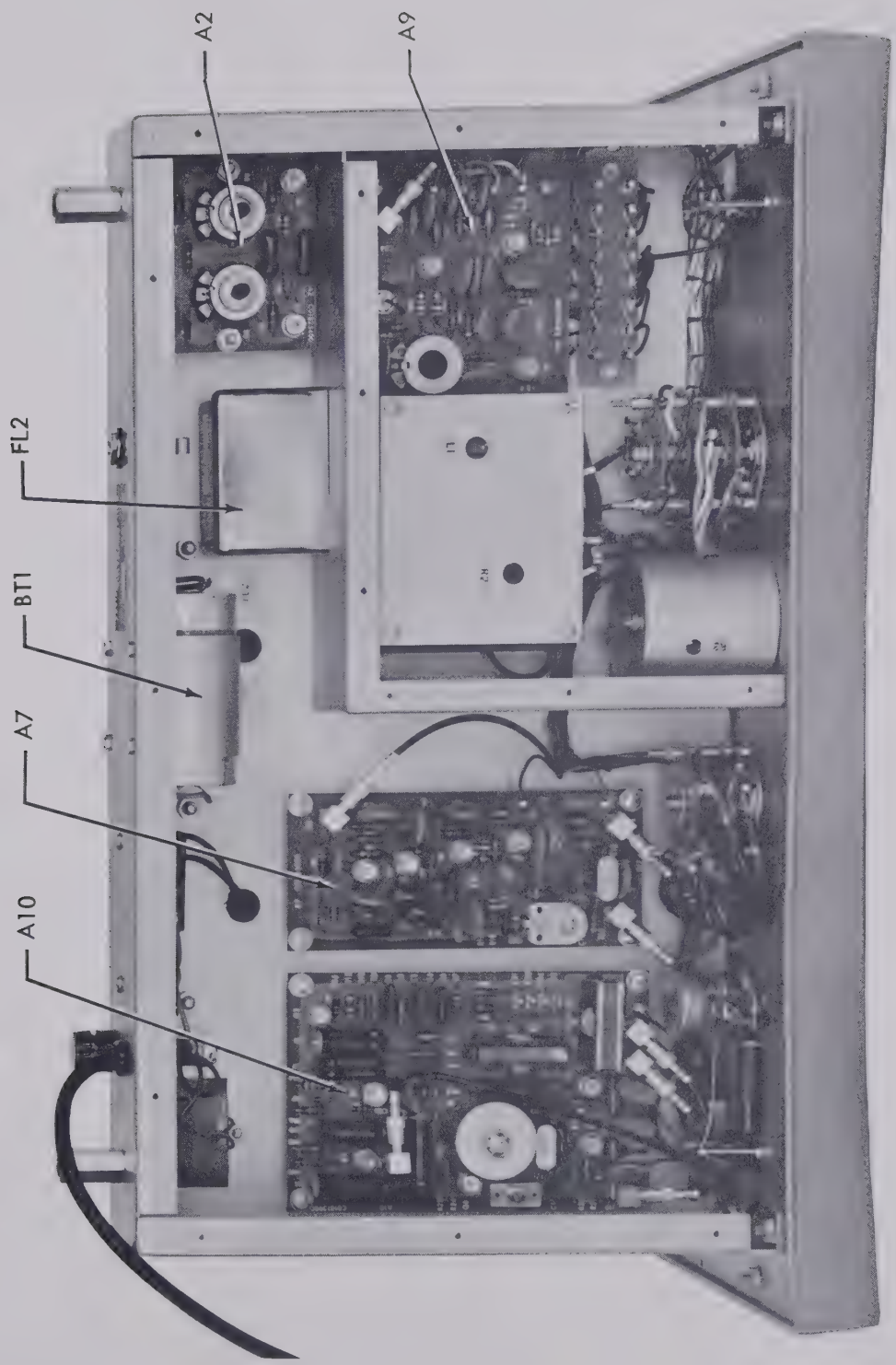


Figure 4-3. Bottom View, Module Location

8. Local Oscillator Tracking

a. Connect Frequency Counter to OUTPUT of 129A. Turn LEVEL control fully clockwise. Set Afc/Sig Gen switch to SIG GEN.

b. Check 0.0 and 100 kc point on Main Tuning dial. Frequency should be within 50 cps at each point. If not, readjust per paragraph 3.e. (Note that counter now reads dial frequency instead of Local Oscillator frequency.)

c. Check calibration at end points and every 10 kc point between, also at 2 kc. Frequency should be within: ±20 cps at 0.0 kc, ±100 cps at 2 and 10 kc, ±200 at each remaining point. Capacitor end plates may be adjusted, going from highest frequency to lowest, to bring readings within tolerance. End points should be rechecked after each adjustment.

9. Input Attenuator Tracking

a. Set Function switch to OPR, Volts Range switch to .03 volts, DB Range switch to 0 db, Bandwidth to 10 cps, AFC to ON, Main Tuning to 1 kc.

b. Insert a 100K ±1% resistor between the Output of the Audio Oscillator and the input of the 129A. Connect an AC VTVM across the output of the Audio Oscillator. Adjust Audio Oscillator output to 30.0 millivolts at 1 kc.

c. Connect the AC VTVM across the Input of the 129A and adjust Input Tracking trimpot A3R2 for an indication of 15.0 millivolts on the AC VTVM.

d. Remove 100K resistor and connect Variable Attenuator between Audio Oscillator and 129A. Terminate Attenuator output with 600 ohms. Connect AC VTVM across 129A Input. Set Volts Range switch to 10 volt position. Set Variable Attenuator to 0 db.

e. Adjust Input level to +20 dbm as read on AC VTVM. Adjust CAL control for a 0 db reading on panel meter.

f. Decrease input level by 10 db steps with Variable Attenuator, at the same time decreasing Volts Range switch in 10 db steps down to the -30 dbm (.03V) position. Meter on 129A should read 0 db at each step within ±0.15 db. Readjust A2R2 as necessary to bring readings within tolerance.

10. Input Attenuator Frequency Response

a. Set Function switch to OPR, Volts Range switch to 1.0 volts, DB Range switch to 0 db, Bandwidth to 10 cps, AFC to ON, Main Tuning to 100 kc. Do not change CAL control setting from paragraph 9.e.

b. Retune Audio Oscillator to 100 kc. Adjust Input level to -20.0 dbm as read on AC VTVM. Adjust A1C1 for a 0 db reading on 129A panel meter.

c. Set Input level to -10 dbm, set Volts Range switch to .30 volts. Adjust A1C2 for a 0 db reading on panel meter.

d. Set Input level to 0 dbm, set Volts Range switch 1.0 volts. Adjust A1C3 for a 0 db reading on panel meter.

11. IF Low-Pass Filter Adjustment

a. Set Function switch to OPR, Volts Range switch to .03 volts, DB Range switch to -60 db, Bandwidth to 100 cps, AFC to OFF, Main Tuning any setting.

b. Connect Audio Oscillator to 129A input and set for a 1.0 volt 205.00 kc signal. Fine tune Audio Oscillator for a maximum reading of 129A panel meter. Adjust DB Range switch if necessary to keep meter reading on scale.

c. Alternately adjust A3C4 and A3C9 for the lowest possible 129A panel meter reading. Variable inductances must not be touched as their adjustment is very critical.

12. Meter Attenuator Tracking

a. Set Function switch to OPR, Volts Range switch to .03 volts, DB Range switch to -60 db, Bandwidth to 10 cps, AFC to ON, Main Tuning to 2 kc.

b. Connect Audio Oscillator to Variable Attenuator. Adjust Audio Oscillator output to -30 dbm. Terminate Variable Attenuator with 600 ohms and set attenuation to 60 db. Connect Variable Attenuator to input of 129A. Set Audio Oscillator to 2 kc. Adjust Cal and Cal Range control for exact 0 db meter reading.

c. Set DB Range switch to -50 db and switch Variable Attenuator to 50 db. Adjust meter tracking potentiometer A9R2 for an exact 0 db reading on panel meter.

SECTION V

REPLACEABLE PARTS LIST

PARTS REPLACEMENT

Standard components have been used in this instrument whenever possible. Both standard and special components may be ordered direct from the factory.

When ordering parts always include:

1. Sierra Stock Number.
2. Circuit Reference and Commercial Description.
3. Name, Model and Serial Number of the Instrument.

Parts for this instrument, or further service information may be obtained from:

SIERRA ELECTRONIC DIVISION
Philco Corporation
3885 Bohannon Drive
Menlo Park, California 94025

Area Code 415
Telephone 326-2060
TWX 492-9224

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	INPUT ATTENUATOR MODULE A1				
C1	CAPACITOR, Ceramic, Variable 5-30 pf 350 Volt	903200300	Erie	557-N750	1
C2	CAPACITOR, Ceramic, Variable 3-12 pf 500 Volt	903230120	Erie	TS2A-NPO	1
C3	CAPACITOR, Ceramic, Variable 1.5-7.0 pf 500 Volt	903210070	Erie	TS2A-NPO	1
R1	RESISTOR, Deposited Carbon, 10 ohm ±1% 1/2 watt	907400016	Electra	DC-1/2A	1
R2	RESISTOR, Deposited Carbon, 21.62 ±1% 1/2 watt	907400017	Electra	DC-1/2A	1
R3	RESISTOR, Deposited Carbon, 68.47 ±1% 1/2 watt	907400146	Electra	DC-1/2A	1
R4	RESISTOR, Deposited Carbon, 217.2 ±1% 1/2 watt	907400147	Electra	DC-1/2A	1
R5	RESISTOR, Deposited Carbon, 99.68K ±1% 2 watt	907800012	Electra	DC-2	1
R6	RESISTOR, Deposited Carbon, 99K ±1% 1/2 watt	907400148	Electra	DC-1/2A	1
R7	RESISTOR, Deposited Carbon, 1.01K ±1% 1/2 watt	907400149	Electra	DC-1/2A	1
R8	RESISTOR, Deposited Carbon, 46.24K ±1% 1/2 watt	907400150	Electra	DC-1/2A	1
R9	RESISTOR, Deposited Carbon, 68.38K ±1% 1/2 watt	907400151	Electra	DC-1/2A	1
R10	RESISTOR, Deposited Carbon, 11.11K ±1% 1/2 watt	907400152	Electra	DC-1/2A	1
R11	RESISTOR, Deposited Carbon, 90K ±1% 1/2 watt	907400153	Electra	DC-1/2A	1
R12	RESISTOR, Deposited Carbon, 3.265K ±1% 1/2 watt	907400154	Electra	DC-1/2A	1
R13	RESISTOR, Deposited Carbon, 96.84K ±1% 1/2 watt	907400155	Electra	DC-1/2A	1
S2	SWITCH, Rotary, Ceramic	911200075	Oak	SS-18144-1	1
	2 KC REF. OSCILLATOR MODULE A2				
C1	CAPACITOR, Dur-Mica .01 mf ±5% 500VDCW	901900103	El-Menco	DM20-103	2
C2	Same as C1				
C3	CAPACITOR, Electrolytic, 6 mf, 15VDCW	902200605	Nashville	1231-5	3
CR1	DIODE, Zener, 7.1 V ±5%	910500030	Hoffman or Equiv.	1N763A	2
J1	RECEPTACLE, 90°, Printed Circuit	914600100	AMP	330732	14
Q1	TRANSISTOR, Germanium	910300007	GE or Equiv.	2N404	3
Q2	Same as Q1				
R1	RESISTOR, Composition 2.7K ohm ±5% 1/2 watt	905000272	Allen Bradley	EB	5
R2	RESISTOR, Composition 33K ohm ±5% 1/2 watt	905000333	Allen Bradley	EB	8
R3	POTENTIOMETER, 5K, 0.75W Linear Taper	907900168	Stackpole	LH61	1
R4	Same as R2				
R5	Same as R1				
R6	RESISTOR, Composition 820 ohm ±5% 1/2 watt	905000821	Allen Bradley	EB	2
R7	RESISTOR, Composition 10K ohm ±5% 1/2 watt	905000103	Allen Bradley	EB	8
R8	POTENTIOMETER, 100 ohm .75W, Linear Taper	907900169	Stackpole	LH61	1
R9	RESISTOR, Composition, 68ohm ±5% 1/2 watt	905000680	Allen Bradley	EB	1

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	PREAMPLIFIER MODULE A3				
C1	CAPACITOR, Electrolytic 67 mfd 15 volts	902200676	Nashville	1231-5	8
C2	Same as C1				
C3	CAPACITOR, Dur-Mica, 270 pf, 500W VDC ±5%	901900271	El-Menco	DM15-271J	2
C4	CAPACITOR, Variable, Ceramic, 7-45 pf	903200450	Erie	TS2A-N500	3
C5	CAPACITOR, Dur-Mica, 62 pf, ±2%, 500VDCW	901900620	El-Menco	DM15-620	2
C6	CAPACITOR, Dur-Mica 1000 pf, ±1%, 500VDCW	901900102	El-Menco	DM19-102	2
C7	Same as C6				
C8	Same as C5				
C9	Same as C4				
C10	Same as C3				
C11	Same as C1				
C12	Same as C1				
C13	CAPACITOR, Electrolytic, 2000 mf, 15 VDCW	902200208	Nashville	1231-5	1
CR1	DIODE, Silicon	910500031	RCA or Equiv.	1N456	5
CR2	Same as CR1				
CR3	DIODE, Zener, 7.1 V ±5%.	910500030	Hoffman or Equiv	1N763A	*
J2	Not used				
J3	RECEPTACLE, 90°, Printed Circuit	914600100	AMP	330732	*
L1	INDUCTOR, Variable	18724 1000	Sierra	SS-18724-1	2
L2	INDUCTOR, Variable	18723 1000	Sierra	SS-18723-1	2
L3	INDUCTOR, Variable	18722 1000	Sierra	SS-18722-1	1
L4	Same as L2				
L5	Same as L1				
Q1	TRANSISTOR, Silicon	910300016	Transitron	2N1249	4
Q2	Same as Q1				
Q3	Same as Q1				
Q4	TRANSISTOR, Germanium	910300008	Philco or Equiv.	2N1728	20
R1	RESISTOR, Composition, 680 ohm ±5% 1/2 watt	905000681	Allen Bradley	EB	3
R2	POTENTIOMETER, 500K ohm 1/4 watt	907900170	Bourns	276-1-504	1
R3	RESISTOR, Composition, 3.9K ohm ±5% 1/2 watt	905000392	Allen Bradley	EB	3
R4	RESISTOR, Composition, 33K ohm ±5% 1/2 watt	905000333	Allen Bradley	EB	*
R5	Same as R4				
R6	RESISTOR, Composition, 100K ohm ±5% 1/2 watt	905000104	Allen Bradley	EB	3
R7	Same as R6				
R8	RESISTOR, Composition, 10K ohm ±5% 1/2 watt	905000103	Allen Bradley	EB	*
R9	RESISTOR, Composition, 1K ohm ±5% 1/2 watt	905000102	Allen Bradley	EB	7
R10	RESISTOR, Composition, 2K ohm ±5% 1/2 watt	905000202	Allen Bradley	EB	2
R11	Same as R10				
R12	RESISTOR, Composition, 22K ohm ±5% 1/2 watt	905000223	Allen Bradley	EB	4
R13	Same as R12				
R14	RESISTOR, Composition, 2.7K ohm ±5% 1/2 watt	905000272	Allen Bradley	EB	3
	LOCAL OSCILLATOR MODULE A4				
C1	CAPACITOR, Electrolytic, 67 MF 15 VDCW	902200676	Nashville	1231-5	*
C2	CAPACITOR, Variable, 9.7-442 pf	902804422	Radio Condenser	Type C	1
C3	CAPACITOR, Piston Trimmer, 0.5 - 11 pf	903000120	JFD	VD-11-G	2

*Previously Accounted For

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
C4	CAPACITOR, Temp. Compensating, 120 pf N330	901400121	Centralab	TCA-120	1
C5	CAPACITOR, Temp. Compensating, 56 pf N330	901400560	Centralab	TCA-56	1
C6	CAPACITOR, Temp. Compensating, 68 pf NPO	901420680	Centralab	TCZ-68	1
C7	CAPACITOR, Mica, 8200 pf 100 VDCW, ±2%	901900822	El-Menco	DM-19	1
C8	CAPACITOR, Mica, 3900 pf 500 VDCW, ±2%	901900392	El-Menco	DM-19	3
C9	CAPACITOR, Mica, 1500 pf 500 VDCW, ±5%	901900152	El-Menco	DM-19	2
C10	CAPACITOR, Voltage Variable 47 pf Nom.	913600011	P.S.I.	V-47	1
C11	CAPACITOR, Variable Air, 5.5-100 pf	902800101	Hammerlund	APC-B-100	1
C12	CAPACITOR, Ceramic Disc. 0.1 mf 50 VDCW	901410104	Sprague	33-C-41	56
C13	Same as C12				
C14	Same as C12				
C15	Same as C12				
C16	Same as C12				
C17	Same as C12				
C18	Same as C12				
CR1	DIODE, Zener, 8.5 Volt	910500035	Hoffman	1N764	1
J4	SOLDER RECEPTACLE, Miniature	914600099	AMP	329852	8
J5	Same as J4				
J6	Same as J4				
L1	INDUCTOR, Variable	187201000	Sierra	SS-18720-1	1
L2	INDUCTOR, Choke, 10 M.H.	909000117	Miller	70F102A1	6
Q1	TRANSISTOR, Silicon	910300023	T.I.	TI484	1
Q2	TRANSISTOR, Germanium	910300008	Philco or Equiv.	2N1728	*
Q3	Same as Q2				
R1	RESISTOR, Comp., 1.5K ±5%, 1/2 watt	905000152	Allen Bradley	EB	3
R2	RESISTOR, Comp., 2.2K ±5%, 1/2 watt	905000222	Allen Bradley	EB	4
R3	RESISTOR, Comp., 12K ±5%, 1/2 watt	905000123	Allen Bradley	EB	9
R4	RESISTOR, Comp., 8.2K±5%, 1/2 watt	905000822	Allen Bradley	EB	4
R5	RESISTOR, Comp., 560Ω±5%, 1/2 watt	905000561	Allen Bradley	EB	2
R6	RESISTOR, Comp., 330K ±5%, 1/2 watt	905000334	Allen Bradley	EB	1
R7	Same as R3				
R8	Same as R4				
R9	RESISTOR, Comp., 3.9K ±5%, 1/2 watt	905000392	Allen Bradley	EB	*
R10	RESISTOR, Comp., 390Ω±5%, 1/2 watt	905000391	Allen Bradley	EB	1
R11	Same as R9				
R12	RESISTOR, Comp., 10K ±5%, 1/2 watt	905000103	Allen Bradley	EB	*
R13	Same as R12				
R14	Same as R1				
	1st IF AMPLIFIER MODULE A5				
C1	CAPACITOR, Mica, 150 pf, 5% 500 VDCW	901900151	El-Menco	DM15	2
C2	CAPACITOR, Ceramic Disc, 0.1 mf, 50 VDCW	901410104	Sprague	33C41	*
C3	Same as C2				
C4	CAPACITOR, Mica, 6800 pf, ±5%, 100 VDCW	901900682	El-Menco	DM19	2
C5	Same as C2				
C6	Same as C2				
C7	Same as C2				
C8	Same as C2				

*Previously Accounted For

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
C9	Same as C2				
C10	Same as C2				
C11	CAPACITOR, Electrolytic, 157 mf, 15 VDCW	902201577	Nashville	1231-5	4
C12	CAPACITOR, Ceramic Disc .1 mf, 50 VDCW	901410104	Sprague	33C41	*
C13	Same as C12				
FL1	FILTER, Crystal, 205 kc, 100 cps BW	910100012	Blackhawk	SS-18256-1	1
J7	RECEPTACLE, 90°, Printed Circuit	914600100	Amp	330732	*
J8	Same as J7				
J9	Same as J7				
J11	Same as J7				
L1	INDUCTOR, Variable	187211000	Sierra	SS-18721-1	1
L2	INDUCTOR, Fixed, 10 mh	909000117	Miller	70F102A1	*
L3	Same as L2				
Q1	TRANSISTOR, Silicon	910300016	Transitron	2N1249	*
Q2	TRANSISTOR, Germanium	910300008	Philco or Equiv.	2N1728	*
Q3	Same as Q2				
R1	RESISTOR, Composition 8.2K ±5% 1/2 watt	905000822	Allen Bradley	EB	*
R2	RESISTOR, Composition 47K ±5% 1/2 watt	905000473	Allen Bradley	EB	3
R3	RESISTOR, Composition 39K ±5% 1/2 watt	905000393	Allen Bradley	EB	5
R4	RESISTOR, Composition 4.7K±5% 1/2 watt	905000472	Allen Bradley	EB	3
R5	RESISTOR, Composition 1K ±5% 1/2 watt	905000102	Allen Bradley	EB	*
R6	Same as R2				
R7	RESISTOR, Composition 33K ±5% 1/2 watt	905000333	Allen Bradley	EB	*
R8	RESISTOR, Composition 3.9K ±5% 1/2 watt	905000392	Allen Bradley	EB	*
R9	RESISTOR, Composition 270 ±5% 1/2 watt	905000271	Allen Bradley	EB	1
R10	RESISTOR, Composition 3.3K ±5% 1/2 watt	905000332	Allen Bradley	EB	6
R11	RESISTOR, Composition 10K ±5% 1/2 watt	905000103	Allen Bradley	EB	*
R12	RESISTOR, Composition 6.8K ±5% 1/2 watt	905000682	Allen Bradley	EB	3
R13	Same as R4				
T1	TRANSFORMER	181273000	Sierra	SA-18127-3	4
	MODULATOR MODULE A6				
C1	CAPACITOR, Mica, 5 pf ± 10%, 500 VDCW	901900050	El-Menco	DM15	1
C2	CAPACITOR, Piston Trimmer, 0.5 - 11 pf	903000120	JFD	VC11-G	*
CR1	DIODE, Germanium	910500003	Transitron	S555G	4
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
R1	RESISTOR, Composition 470Ω ±5% 1/4 watt	906900471	Allen Bradley	CB	4
R2	Same as R1				
R3	Same as R1				
R4	Same as R1				
R5	POTENTIOMETER, Comp., Trimmer, 100Ω 1/4 watt	907900175	Bourns	275-101	1
T1	TRANSFORMER, Modulator	181273000	Sierra	SA-18127-3	*

*Previously Accounted For

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
	AFC AMPLIFIER - LIMITER MODULE A7				
C1	CAPACITOR, Disc Ceramic, 0.1 mf 50 VDCW	901410104	Sprague	33C41	*
C2	CAPACITOR, Mica, 2000pf ±5%, 500VDCW	901900202	El-Menco	DM19-202J	3
C3	CAPACITOR, Disc Ceramic, 0.1mf, 50VDCW	901410104	Sprague	33C41	1
C4	Same as C1				
C5	CAPACITOR, Mica, 3900 pf ±2%, 500 VDCW	901900392	El-Menco	DM19	*
C6	Same as C5				
C7	Same as C1				
C8	CAPACITOR, Mica, 2000 pf ±5%, 500 VDCW	901900202	El-Menco	DM19	1
C9	Same as C1				
C10	Same as C1				
C11	Same as C1				
C12	Same as C1				
C13	CAPACITOR, Mica, 120 pf ±5% 500 VDCW	901900121	El-Menco	DM15	1
C14	CAPACITOR, Mica, Variable, 7.45 pf	903200450	Erie	TS2AN500	*
C15	CAPACITOR, Mica, 150pf ±5%,500 VDCW	901900151	El-Menco	DM15-151J	*
C16	Same as C1				
C17	CAPACITOR, Electrolytic, 6 mf 15 VDCW	902200605	Nashville	1231-5	*
C18	Same as C1				
CR1	DIODE, Germanium	910600191	Transitron or Equiv.	1N191	6
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
J10	RECEPTACLE, 90°, Printed Circuit	914600100	AMP	330732	*
J13	Same as J10				
J14	Same as J10				
L1	INDUCTOR, .33 mh	909000106	Miller	70F334A1	3
L2	Same as L1				
L3	Same as L1				
L4	INDUCTOR, 10 mh	909000117	Miller	70F102A1	*
Q1	TRANSISTOR, Germanium	910300008	Philco or Equiv.	2N1728	4
Q2	Same as Q1				
Q3	Same as Q1				
Q4	Same as Q1				
R1	RESISTOR, Comp., 27K ±5% 1/2 watt	905000273	Allen Bradley	EB	1
R2	RESISTOR, Comp., 10K ±5% 1/2 watt	905000103	Allen Bradley	EB	*
R3	RESISTOR, Comp., 120Ω ±5% 1/2 watt	905000121	Allen Bradley	EB	4
R4	RESISTOR, Comp., 3.3K ±5% 1/2 watt	905000332	Allen Bradley	EB	*
R5	RESISTOR, Comp., 12K ±5% 1/2 watt	905000123	Allen Bradley	EB	*
R6	Same as R5				
R7	RESISTOR, Comp., 5.6K ±5% 1/2 watt	905000562	Allen Bradley	EB	4
R8	RESISTOR, Comp.,82K ±5% 1/2 watt	905000823	Allen Bradley	EB	2
R9	RESISTOR, Comp., 33K ±5% 1/2 watt	905000333	Allen Bradley	EB	*
R10	RESISTOR, Comp., 680Ω ±5% 1/2 watt	905000681	Allen Bradley	EB	*
R11	RESISTOR, Comp., 2.7K ±5% 1/2 watt	905000272	Allen Bradley	EB	*
R12	RESISTOR, Comp., 4.7K ±5% 1/2 watt	905000412	Allen Bradley	EB	1
R13	RESISTOR, Comp., 1.8K ±5% 1/2 watt	905000182	Allen Bradley	EB	4
R14	RESISTOR, Comp., 3.9K ±5% 1/2 watt	905000393	Allen Bradley	EB	*

*Previously Accounted For

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
R15	Same as R14				
R16	Same as R13				
R17	RESISTOR, Comp., 6.8K ±5% 1/2 watt	905000682	Allen Bradley	EB	*
R18	RESISTOR, Comp., 1.2K ±5% 1/2 watt	905000122	Allen Bradley	EB	3
R19	RESISTOR, Comp., 22K ±5% 1/2 watt	905000223	Allen Bradley	EB	*
R20	RESISTOR, Comp., 120K ±5% 1/2 watt	905000124	Allen Bradley	EB	2
R21	Same as R20				
R22	RESISTOR, Comp., 470K ±5% 1/2 watt	905000474	Allen Bradley	EB	2
R23	RESISTOR, Comp., 150 ohm, ±5%, 1/2 watt	905000151	Allen Bradley	EB	1
Y1	CRYSTAL, Peizoelectric 204.970 KC	912200025	Monitor	CR25	1
	METER ATTENUATOR MODULE A8				
R1	RESISTOR, Dep. Carb., 3.996K ±1% 1/2 watt	907400156	Electra	DC-1/2	1
R2	RESISTOR, Dep. Carb., 3.987K ±1% 1/2 watt	907400157	Electra	DC-1/2	1
R3	RESISTOR, Dep. Carb., 3.960K ±1% 1/2 watt	907400158	Electra	DC-1/2	1
R4	RESISTOR, Dep. Carb., 3.870K ±1% 1/2 watt	907400159	Electra	DC-1/2	1
R5	RESISTOR, Dep. Carb., 3.600K ±1% 1/2 watt	907400160	Electra	DC-1/2	1
R6	RESISTOR, Dep. Carb., 2.735K ±1% 1/2 watt	907400161	Electra	DC-1/2	1
R7	RESISTOR, Dep. Carb., 4.000Ω ±1% 1/2 watt	907400162	Electra	DC-1/2	1
R8	RESISTOR, Dep. Carb., 12.69Ω ±1% 1/2 watt	907400163	Electra	DC-1/2	1
R9	RESISTOR, Dep. Carb., 40.40Ω ±1% 1/2 watt	907400164	Electra	DC-1/2	1
R10	RESISTOR, Dep. Carb., 130.6 Ω ±1% 1/2 watt	907400165	Electra	DC-1/2	1
R11	RESISTOR, Dep. Carb., 444.4Ω ±1% 1/2 watt	907400166	Electra	DC-1/2	1
R12	RESISTOR, Dep. Carb., 1.85K ±1% 1/2 watt	907400167	Electra	DC-1/2	1
S4	SWITCH, Rotary, Ceramic	911200074	Oak	SS-18145-1	1
	2nd IF AND METER CIRCUIT MODULE A9				
C1	CAPACITOR, Disc Ceramic 0.1 mf 50 VDCW	901410104	Sprague	33C-41	*
C2	Same as C1				
C3	Same as C1				
C4	Same as C1				
C5	Same as C1				
C6	Same as C1				
C7	Same as C1				
C8	CAPACITOR, Mica, 1500 pf ±5% 500 VDCW	901900152	El-Menco	DM19	*
C9	Same as C1				
C10	Same as C1				
C11	Same as C1				
C12	Same as C1				
C13	Same as C1				
C14	Same as C1				
C15	Same as C1				
C16	Same as C1				
C17	Same as C1				
C18	Same as C1				
C19	Same as C1				
C20	Same as C1				
C21	Same as C1				

*Previously Accounted For

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
C22	Same as C1				
C23	Same as C1				
C24	Same as C1				
CR1	DIODE, Germanium	910600191	Transitron	1N191	*
CR2	Same as CR1				
J12	SOLDER RECEPTACLE, Miniature	914600099	AMP	329852	*
J15	Same as J12				
J16	Same as J12				
J20	Same as J12				
J22	Same as J12				
J23	RECEPTACLE, 90°, Printed Circuit	914600100	AMP	330732	*
L1	INDUCTOR, 0.5 mh	187191000	Sierra	SS-18719-1	2
L2	INDUCTOR, 3.3 mh RFC	909000116	Miller	70F333A1	4
L3	Same as L2				
Q1	TRANSISTOR, Germanium	910300007	Philco or RCA	2N404	*
Q2	TRANSISTOR, Germanium	910300008	Philco or equiv	2N1728	
Q3	Same as Q2				
Q4	Same as Q2				
Q5	Same as Q2				
Q6	Same as Q2				
R1	RESISTOR, Comp. 5.6K ±5% 1/2 watt	905000562	Allen Bradley	EB	*
R2	POTENTIOMETER, Comp. 2K, 2W	907900176	Stackpole	LH61	1
R3	RESISTOR, Comp. 82K ±5% 1/2 watt	905000823	Allen Bradley	EB	*
R4	RESISTOR, Comp. 33K ±5% 1/2 watt	905000333	Allen Bradley	EB	*
R5	RESISTOR, Comp. 3.9K ±5% 1/2 watt	905000392	Allen Bradley	EB	*
R6	RESISTOR, Comp. 470Ω ±5% 1/2 watt	905000471	Allen Bradley	EB	1
R7	RESISTOR, Comp. 1.8K ±5% 1/2 watt	905000182	Allen Bradley	EB	*
R8	RESISTOR, Comp. 120Ω ±5% 1/2 watt	905000121	Allen Bradley	EB	*
R9	RESISTOR, Comp. 1K ±5% 1/2 watt	905000102	Allen Bradley	EB	*
R10	RESISTOR, Comp. 12K ±5% 1/2 watt	905000123	Allen Bradley	EB	*
R11	RESISTOR, Comp. 8.2K ±5% 1/2 watt	905000822	Allen Bradley	EB	*
R12	RESISTOR, Comp. 2.2K ±5% 1/2 watt	905000222	Allen Bradley	EB	3
R13	RESISTOR, Comp. 220Ω ±5% 1/2 watt	905000221	Allen Bradley	EB	1
R14	RESISTOR, Comp. 3.3K ±5% 1/2 watt	905000332	Allen Bradley	EB	*
R15	Same as R8				
R16	RESISTOR, Comp. 56K ±5% 1/2 watt	905000563	Allen Bradley	EB	2
R17	RESISTOR, Comp. 10K ±5% 1/2 watt	905000103	Allen Bradley	EB	*
R18	RESISTOR, Comp. 5.6K ±5% 1/2 watt	905000562	Allen Bradley	EB	*
R19	POTENTIOMETER, Comp. 1K 2W	907900101	Stackpole	LH61	1
R20	Same as R9				
R21	Same as R4				
R22	Same as R10				
R23	Same as R14				
R24	RESISTOR, Comp. 2.7K ±5% 1/2 watt	905000272	Allen Bradley	EB	*
R25	RESISTOR, Comp. 22K ±5% 1/2 watt	905000223	Allen Bradley	EB	*
R26	Same as R17				
R27	RESISTOR, Comp. 1.2K ±5% 1/2 watt	905000122	Allen Bradley	EB	*
R28	Same as R7				
R29	Same as R27				
R30	RESISTOR, Comp. 150 Ω ±5% 1/2 watt	905000151	Allen Bradley	EB	1
R31	RESISTOR, Comp. 39K ±5% 1/2 watt	905000393	Allen Bradley	EB	*

*Previously Accounted For

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
R32	Same as R31				
R33	RESISTOR, Comp. 68K±5% 1/2 watt	905000683	Allen Bradley	EB	1
R34	Same as R18				
R35	Same as R9				
	SIGNAL RESTORER MODULE A10				
C1	CAPACITOR, Disc Ceramic, 0.1 mf 50 VDCW	901410104	Sprague	33G41	*
C2	Same as C1				
C3	Same as C1				
C4	CAPACITOR, Mica, 1200 pf ±5%, 500 VDCW	901900122	El-Menco	DM19	2
C5	CAPACITOR, Mica, 2200 pf ±5%, 500 VDCW	901900222	El-Menco	DM19	1
C6	Same as C4				
C7	CAPACITOR, Electrolytic, 157 mf, 15 VDCW	902201577	Nashville	1231-5	*
C8	CAPACITOR, Electrolytic, 67 mf, 15 VDCW	902200676	Nashville	1231-5	*
C9	Same as C8				
C10	Same as C8				
C11	Same as C7				
C12	Same as C1				
C13	Same as C1				
C14	Same as C1				
C15	CAPACITOR, Mica, 47 pf ±5% 500 VDCW	901900470	El-Menco	DM15	2
C16	CAPACITOR, Mica, Variable 7-100 pf	903200101	Arco	423	1
C17	CAPACITOR, Mica, 6800pf ±5% 100VDCW	901900682	El-Menco	DM19-682J	*
C18	CAPACITOR, Mica, 2000pf ±5% 500 VDCW	901900202	El-Menco	DM19-202J	*
C19	CAPACITOR, Mica, 47pf±5%, 500VDCW	901900470	El-Menco	DM15-470J	*
CR1	DIODE, Germanium	910600191	Transitron	1N191	4
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
CR5	DIODE, Silicon	910500031	Transitron	1N456	*
CR6	Same as CR5				
CR7	Same as CR5				
J17	RECEPTACLE, 90°, Printed Circuit	914600100	AMP	330732	*
J18	Same as J17				
J19	Same as J17				
J21	Same as J17				
L1	COIL, RFC, 10.0 mh	909000117	Miller	70F102A1	*
L2	COIL, RFC, 3.3 mh	909000116	Miller	70F333A1	*
L3	Same as L2				
L4	Same as L1				
L5	COIL, Oscillator, 0.5 mh	187191000	Sierra	SS-18719-1	*
Q1	TRANSISTOR, Germanium	910300008	Philco	2N1728	*
Q2	Same as Q1				
Q3	Same as Q1				
Q4	Same as Q1				
Q5	Same as Q1				
Q6	Same as Q1				

*Previously Accounted For

REPLACEABLE PARTS LIST

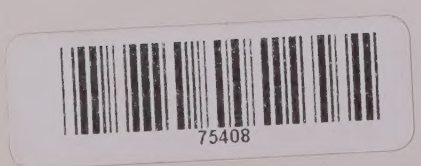
Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
R1	RESISTOR, Comp. 12K ±5% 1/2 watt	905000123	Allen Bradley	EB	*
R2	Same as R1				
R3	RESISTOR, Comp. 3.3K ±5% 1/2 watt	905000332	Allen Bradley	EB	*
R4	RESISTOR, Comp. 100Ω ±5% 1/2 watt	905000101	Allen Bradley	EB	2
R5	Same as R4				
R6	RESISTOR, Comp. 1.5K ±5% 1/2 watt	905000152	Allen Bradley	EB	*
R7	RESISTOR, Comp. 2.2K ±5% 1/2 watt	905000222	Allen Bradley	EB	*
R8	Same as R7				
R9	RESISTOR, Comp. 56K ±5% 1/2 watt	905000563	Allen Bradley	EB	*
R10	RESISTOR, Comp. 6.8K ±5% 1/2 watt	905000682	Allen Bradley	EB	*
R11	RESISTOR, Comp. 8.2K ±5% 1/2 watt	905000822	Allen Bradley	EB	1
R12	RESISTOR, Comp. 330Ω ±5% 1/2 watt	905000331	Allen Bradley	EB	1
R13	RESISTOR, Comp. 47K ±5% 1/2 watt	905000473	Allen Bradley	EB	*
R14	Same as R1				
R15	RESISTOR, Comp. 4.7K ±5% 1/2 watt	905000472	Allen Bradley	EB	*
R16	RESISTOR, Comp. 680Ω ±5% 1/2 watt	905000681	Allen Bradley	EB	*
R17	RESISTOR, Comp. 15K ±5% 1/2 watt	905000153	Allen Bradley	EB	1
R18	RESISTOR, Comp. 22K ±5% 1/2 watt	905000223	Allen Bradley	EB	*
R19	RESISTOR, Comp. 1K ±5% 1/2 watt	905000102	Allen Bradley	EB	*
R20	RESISTOR, Comp. 820Ω ±5% 1/2 watt	905000821	Allen Bradley	EB	*
R21	RESISTOR, Comp. 560Ω ±5% 1/2 watt	905000561	Allen Bradley	EB	*
R22	RESISTOR, Comp. 5.6K ±5% 1/2 watt	905000562	Allen Bradley	EB	*
R23	Same as R18				
R24	Same as R18				
R25	Same as R18				
R26	Same as R18				
T1	TRANSFORMER	181273000	Sierra	SS-18127-3	*
T2	Same as T1				
Y1	CRYSTAL, Peizoelectric, 204.970 KC ±.01% -40 to +70°C	912200024	Monitor	CR25	1
	COMPONENTS OTHER THAN MODULES				
BT1	BATTERY, Rechargeable, Nickel Cadmium, 12 volt 450 M.A.H. Capacity	918500013	Burgess	CD29	1
C1	CAPACITOR, Electrolytic, 168 mf 50 VDCW	902201687	Nashville	1231-5	1
C2	CAPACITOR, Disc. Ceram., 0.1 mf 50 VDCW	901410104	Sprague	33C41	*
C3	CAPACITOR, Electrolytic 157 mf 15 VDCW	902201577	Nashville	1231-5	*
C4	CAPACITOR, Electrolytic, 6mf, 15 VDCW	902200605	Nashville	1231-5	*
CR1	DIODE, Silicon	910800008	Diodes Inc	DI 56	4
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
DS1	LAMP, Incandescent 12V	913800022	GE	344	1
	LAMP SOCKET, Red Lens	914200039	Dialco	101-4630-931	1
F1	FUSE, Cartridge, 115V 0.1A	913200035	Buss	3AG	1
FL2	FILTER, Crystal 205 kc 10 cps BW	910100011	Blackhawk	A01718600	1

*Previously Accounted For

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
J24	JACK, 2 Cond., Closed Ckt.	914400011	Switchcraft	C12A	1
L1	INDUCTOR, 4 Henry 130 ma 100Ω DCR	909200036	Thordarson	20C64	2
L2	Same as L1				
M1	METER, Taut Band, 200 microamp. dc	911800054	Sierra	SS-18146-1B	1
P1	PLUG KIT, Coaxial, Miniature	914600097	AMP	2-329036-1	22
P2	Not used				
P3	Same as P1				
P4	Same as P1				
P5	Same as P1				
P6	Same as P1				
P7	Same as P1				
P8	Same as P1				
P9	Same as P1				
P10	Same as P1				
P11	Same as P1				
P12	Same as P1				
P13	Same as P1				
P14	Same as P1				
P15	Same as P1				
P16	Same as P1				
P17	Same as P1				
P18	Same as P1				
P19	Same as P1				
P20	Same as P1				
P21	Same as P1				
P22	Same as P1				
P23	Same as P1				
R1	RESISTOR, Composition, 120Ω ±5% 1/2 watt	905000121	Allen Bradley	EB	*
R2	RESISTOR, Composition, 2.2K ±5% 1/2 watt	905000222	Allen Bradley	EB	*
R3	POTENIOMETER, 2K, Wirewound 1/4 watt	907900177	Bournes	273-1-202	1
R4	RESISTOR, Composition, 1K ±5% 1/2 watt	905000102	Allen Bradley	EB	*
R5	RESISTOR, Composition, 3.3K ±5% 1/2 watt	905000332	Allen Bradley	EB	*
R6	RESISTOR, Composition, 620Ω ±5% 1/2 watt	905000621	Allen Bradley	EB	2
R7/8	ATTENUATOR, Bridged "T", 600Ω ±20%	912100003	Allen Bradley	JJ88551	1
R9	Same as R6				
R10	RESISTOR, Composition, 100K ±5% 1/2 watt	905000104	Allen Bradley	EB	*
R11	POTENIOMETER, Composition 100Ω ±10% 1/2 watt Lin Taper	907900178	Chicago Tel. of Calif.		1
R12	RESISTOR, Composition, 470K, ±5%, 1/2 watt	905000474	Allen Bradley	EB	*
S1	SWITCH, Rotary, Ceramic	911200073	Oak	SS-18154-1	1
S3	SWITCH, Rotary, Ceramic	911200072	Oak	SS-18153-1	1
S5	SWITCH, Rotary, Ceramic	911200081	Oak	SS-18165-1	1
T1	TRANSFORMER, Power	910000068	Tranex	SS-18190-1A	1

*Previously Accounted For


75408